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(54) MAGNETIC HEAD FOR VERTICAL RECORDING AND DISK MAGNETIC DEVICE OF LOADING THE SAME

(57)Abstract:
PROBLEM TO BE SOLVED: To produce a magnetic head for vertical recording which generates no noise, and to obtain a magnetic disk device of high stability by using the same.
SOLUTION: The magnetic head for vertical recording which uses main magnetic poles comprising multiplayer of magnetic/non-magnetic films is produced so that the magnetic zone is stabilized and the generation of the noise is also suppressed.

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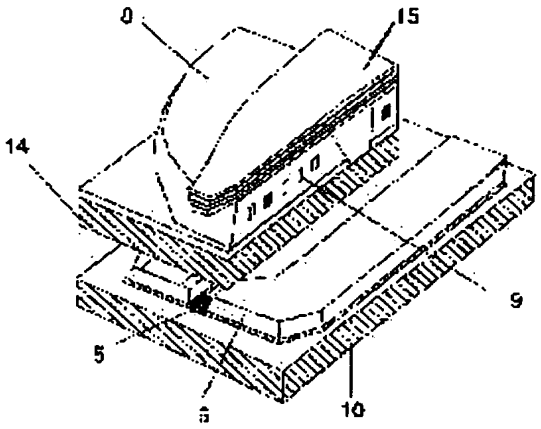

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CLAIMS

[Claim(s)]
[Claim 1] Two or more sensor electrodes with which it is arranged on the interlayer insulation film on a substrate, and insulating separation of each is carried out, The passivation membrane which covers respectively the top face and side face of said each electrode of a sensor, and is arranged on said interlayer insulation film, and consists of a dielectric, The capacity detector which detects the electrostatic capacity formed between the front faces of said recognition object which counters said sensor electrode and this sensor electrode when a recognition object contacts said passivation membrane front face, Surface type-like recognition equipment characterized by having a static electricity evasion means to pass static electricity on said passivation membrane front face.
[Claim 2] It is surface type-like recognition equipment characterized by being the ground electrode with which insulating separation of said static electricity evasion means is carried out with said sensor electrode in claim 1, and it is formed on said interlayer insulation film, and a part forms one front face with said passivation membrane.
[Claim 3] It is surface type-like recognition equipment characterized by consisting of a ground electrode with which insulating separation of said static electricity evasion means is carried out with said sensor electrode in claim 1, and it is formed on said interlayer insulation film, and a part forms one front face with said passivation membrane, and said capacity detector and the electrostatic-protection component prepared in sensor inter-electrode.
[Claim 4] Said capacity detector is surface type-like recognition equipment characterized by being formed as an integrated circuit on the substrate with which said sensor electrode and passivation membrane were formed in claim 1.
[Claim 5] Surface type-like recognition equipment characterized by having the processing circuit which is formed as an integrated circuit on a substrate with said capacity detector, processes the detection output of this capacity detector in claim 4, and is outputted as the shape of surface type of said recognition object.
[Claim 6] It is surface-type-like recognition equipment characterized by to be connected said ground electrode to the reference electrode with which potential predetermined in the outside of the field where said sensor electrode has been arranged is given while each sensor electrode is formed in the magnitude in which two or more sensor electrodes are covered with the contact surface of said recognition object in contact with said passivation membrane front face in claim 2, respectively and said capacity detector is formed in the bottom of said interlayer insulation film on said substrate.
[Claim 7] It is surface-type-like recognition equipment with which it has the processing circuit which processes the detection output of said capacity detecting element, and outputs as the shape of surface type of said recognition object in claim 6, and said processing circuit is characterized by to be detected by said capacity detector, to process the difference of each electrostatic capacity corresponding to each sensor electrode, and to output as the shape of surface type of said recognition object when said recognition object contacts said passivation membrane front face.
[Claim 8] It is surface type-like recognition equipment characterized by arranging said sensor electrode in the center of the measure of the ground electrode which said ground electrode was formed in the shape of a grid in claim 2, and was formed in the shape of [this] a grid.
[Claim 9] It is surface type-like recognition equipment characterized by said some of ground electrodes forming one flat surface with said passivation membrane in claim 2.

[Claim 10] It is surface type-like recognition equipment characterized by giving touch-down potential in claim 6, as for said reference electrode.
[Claim 11] It is surface-type-like recognition equipment which said capacity detector consists of a signal generating circuit which it is connected [signal generating circuit] with said sensor electrode and generates the signal according to said electrostatic capacity, and an output circuit which will change and output to a desired signal if the signal generated in the connection of said sensor electrode and signal generating circuit is inputted in claim 1, and is characterized by to be formed said static electricity evasion means as an electrostatic-protection component in the input side of all the circuits connected to said sensor electrode.
[Claim 12] Said electrostatic-protection component is surface type-like recognition equipment which consists of an MOS transistor by which the terminal of either a source terminal and a drain terminal is connected to said sensor electrode in claim 11, and is characterized by forming parasitism pn diode between one [said] terminal of said MOS transistor, and the substrate or well in which this MOS transistor is formed.
[Claim 13] The signal generating circuit which said capacity detector is connected [signal generating circuit] to said sensor electrode, and generates the signal according to said electrostatic capacity in claim 1, Said sensor electrode and the signal amplifying circuit which amplifies the signal generated in the connection of a signal generating circuit, It is surface type-like recognition equipment which consists of an output circuit which changes and outputs the signal from said signal amplifying circuit to a desired signal, and is characterized by including said static electricity evasion means in the input of said signal amplifying circuit connected to said sensor electrode.
[Claim 14] It is surface type-like recognition equipment which consists of MOS transistors to which, as for said signal amplifying circuit, the terminal of either a source terminal and a drain terminal was connected as said input to said sensor electrode in claim 13, and is characterized by forming parasitism pn diode between one [said] terminal of said MOS transistor, and the substrate or well in which this MOS transistor is formed.
[Claim 15] It is surface-type-like recognition equipment which said capacity detector consists of a signal generating circuit which it connects [signal generating circuit] with said sensor electrode and generates the signal according to said electrostatic capacity, and an output circuit which will be changed and outputted to a desired signal if the signal generated in the connection of said sensor electrode and signal generating circuit is inputted in claim 1, and is characterized by to be established said static electricity evasion means as an electrostatic-protection component between said sensor electrodes and output circuits.
[Claim 16] Said electrostatic-protection component is surface type-like recognition equipment characterized by for any of a source terminal and a drain terminal or an other-end child consisting of an MOS transistor connected to the input side of said output circuit, and forming parasitism pn diode between one [said] terminal of said MOS transistor, and the substrate or well in which said MOS transistor is formed while the terminal of either said source terminal and a drain terminal is connected to said sensor electrode in claim 15.
[Claim 17] Two or more sensor electrodes with which it is arranged on the interlayer insulation film on a substrate, and insulating separation of each is carried out, The passivation membrane which covers respectively the top face and side face of said each electrode of a sensor, and is arranged on said interlayer insulation film, and consists of a dielectric, The ground electrode with which insulating separation is carried out with said sensor electrode, and it is formed on said interlayer insulation film, and a part forms one front face with said passivation membrane, It has the capacity detection means which consists of an integrated circuit which detects the capacity formed between said sensor electrode and said front face for recognition which counters this when the part for recognition contacted said passivation membrane front face. Said sensor electrode is formed in the magnitude with which said two or more sensor electrodes are covered when said candidate for recognition touches said passivation membrane. Said capacity detection means It is formed in the bottom of said interlayer insulation film on said substrate. Said ground electrode It connects with the reference electrode with which fixed potential predetermined in the outside of the field where said sensor electrode has been arranged is given. Surface type-like recognition equipment characterized by recognizing the shape of surface type for [said] recognition by change of the capacity corresponding to each the electrode of said sensor which said capacity detection means detected

when said candidate for recognition contacted said passivation membrane front face.
[Claim 18] It is surface type-like recognition equipment characterized by arranging said sensor electrode in the center of the measure of the ground electrode which said ground electrode was formed in the shape of a grid in claim 17, and was formed in the shape of [this] a grid.
[Claim 19] It is surface type-like recognition equipment characterized by said some of ground electrodes forming one flat surface with said passivation membrane in claim 17 or claim 18.
[Claim 20] It is surface type-like recognition equipment characterized by giving touch-down potential in which claim of claim 17 thru/or claim 19, as for said reference electrode.
[Claim 21] The sensing element from which quantity of electricity changes according to the configuration of the front face of a detection object, and the signal generating circuit which it connects [signal generating circuit] with said sensing element and generates the signal according to said quantity of electricity, In the surface type-like recognition equipment which consists of an output circuit which will be changed and outputted to a desired signal if the signal generated in the connection of said sensing element and signal generating circuit is inputted While having the MOS transistor by which either a source terminal and a drain terminal are connected to this sensing element as an input of all the circuits connected to said sensing element Surface type-like recognition equipment characterized by using the parasitism pn diode formed between the substrates or wells which form either and said MOS transistor of a source terminal and a drain terminal as a protection component.
[Claim 22] The sensing element from which quantity of electricity changes according to the configuration of the front face of a detection object, and the signal generating circuit which it connects [signal generating circuit] with said sensing element and generates the signal according to said quantity of electricity, Said sensing element and the signal amplifying circuit which amplifies the signal generated in the connection of a signal generating circuit, It is surface type-like recognition equipment which consists of an output circuit which changes and outputs the inputted signal to a desired signal from said signal amplifying circuit. While having the MOS transistor by which either a source terminal and a drain terminal are connected to this sensing element as an input of said signal amplifying circuit connected to said sensing element Surface type-like recognition equipment characterized by using the parasitism pn diode formed between the substrates or wells which form either and said MOS transistor of a source terminal and a drain terminal as a protection component.
[Claim 23] The sensing element from which quantity of electricity changes according to the configuration of the front face of a detection object, and the signal generating circuit which it connects [signal generating circuit] with said sensing element and generates the signal according to said quantity of electricity, In the surface type-like recognition equipment which consists of an output circuit which will be changed and outputted to a desired signal if the signal generated in the connection of said sensing element and signal generating circuit is inputted While having the MOS transistor by which either a source terminal and a drain terminal are connected to said sensing element Any of the source terminal of said MOS transistor and a drain terminal or another side is connected to the input side of said output circuit. And surface type-like recognition equipment characterized by using the parasitism pn diode formed between the substrates or wells which form either and said MOS transistor of a source terminal and a drain terminal as a protection component.

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DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] It is the sectional view of the sensor chip in which the gestalt of operation of the 1st of the surface type-like recognition equipment concerning this invention is shown.
[Drawing 2] It is the top view of said sensor chip.
[Drawing 3] It is the circuit diagram of a capacity detector showing the gestalt of operation of the 2nd of this invention.
[Drawing 4] It is drawing showing the important section configuration of the capacity detector of drawing 3 .
[Drawing 5] It is drawing showing the equal circuit of the capacity detector of drawing 4 .
[Drawing 6] It is the circuit diagram of a capacity detector showing the gestalt of operation of the 3rd of this invention.
[Drawing 7] It is drawing showing the important section configuration of the capacity detector of drawing 6 .
[Drawing 8] It is drawing showing the equal circuit of the capacity detector of drawing 7 .
[Drawing 9] It is the circuit diagram of a capacity detector showing the gestalt of operation of the 6th of this invention.
[Drawing 10] It is the sectional view of the conventional sensor chip.
[Drawing 11] It is the top view of the conventional sensor chip.
[Drawing 12] It is the circuit diagram of the conventional capacity detector.
[Description of Notations]
1 [-- Lower layer insulator layer,] -- A sensing element, 100 -- A recognition object, 101 -- A semiconductor substrate, 102 103 [-- Detection field,] -- Wiring, 104 -- An interlayer insulation film, 105 -- A sensor electrode, 105a 106 [-- Passivation membrane,] -- A ground electrode, 106a -- Wiring, 106b -- A pad, 107 200,200A, 200B -- A capacity detector, 210 -- Signal generating circuit, 211 [-- A PchMOS transistor, Q2, Q3 and Q5, Q5A, a Q5 B--NchMOS transistor, D1, D2 / -- Parasitism diode, Cf / -- Capacity value, Cp0, Cp1 / -- Parasitic capacitance, N1, N2 / -- Joint.] -- A current source, 220 -- An output circuit, 300 -- A processing circuit, Q1, Q4

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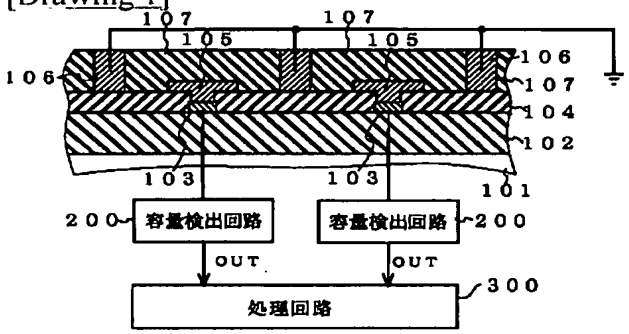
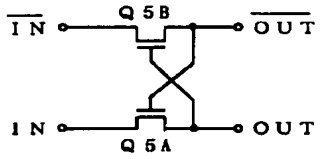
DRAWINGS

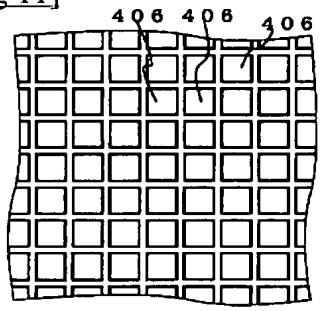
[Drawing 1]



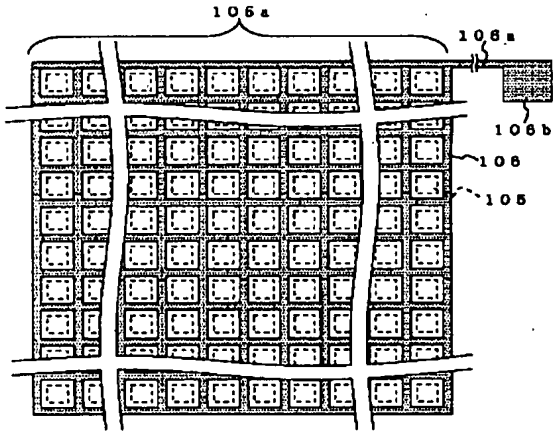
[Drawing 9]



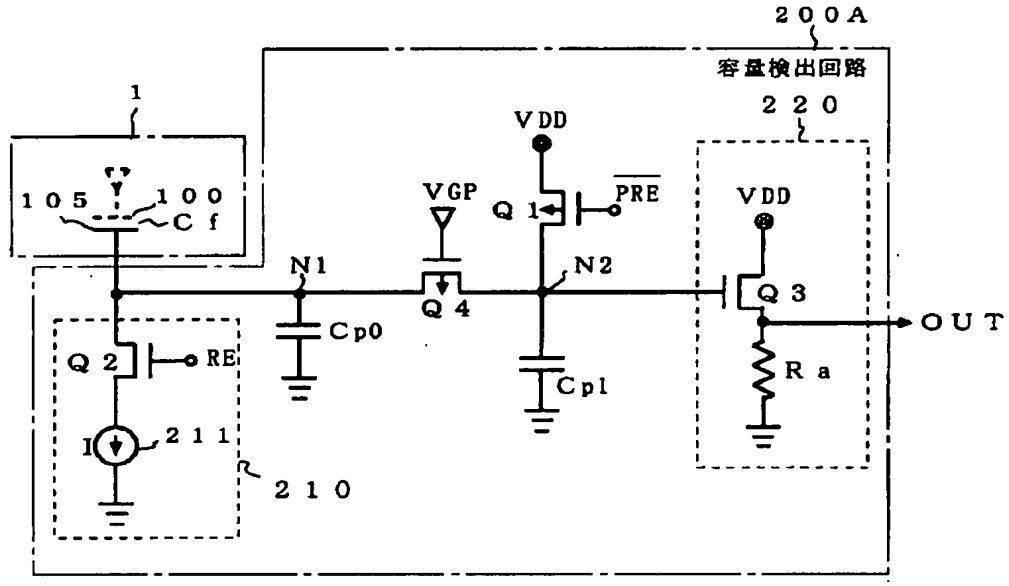
[Drawing 11]



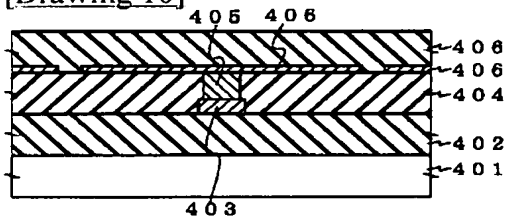
[Drawing 2]



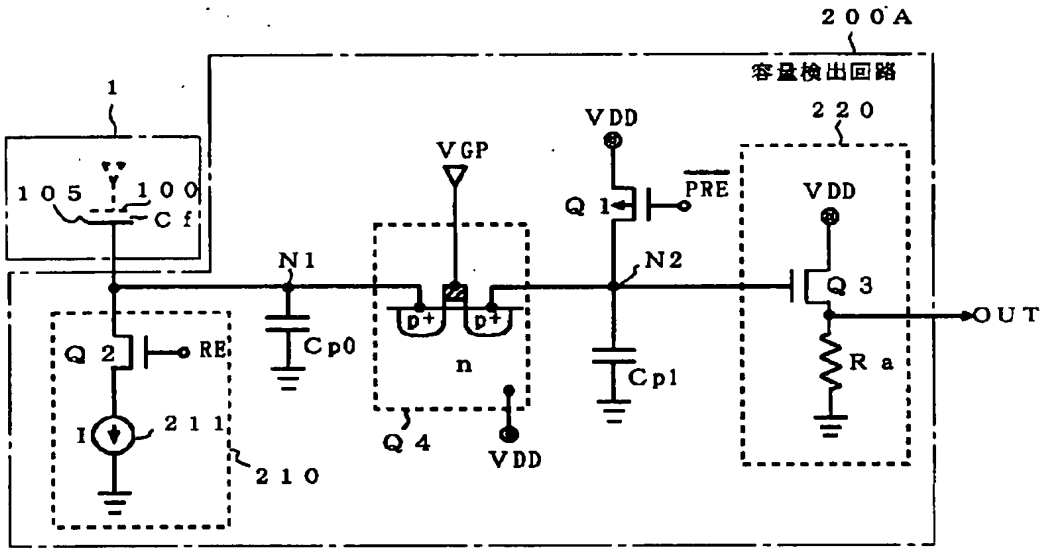
[Drawing 3]



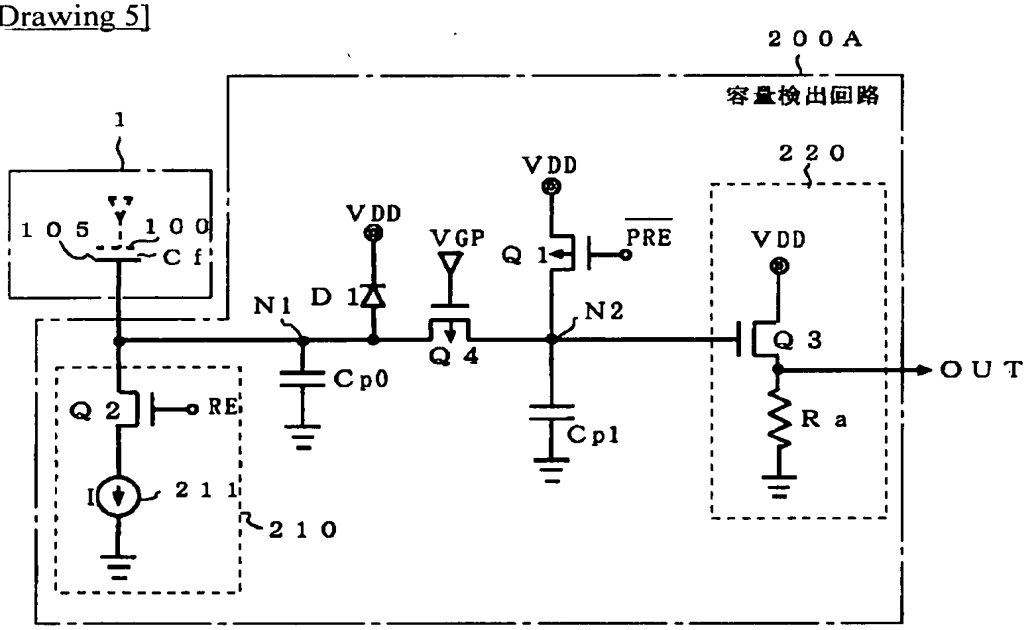
[Drawing 10]



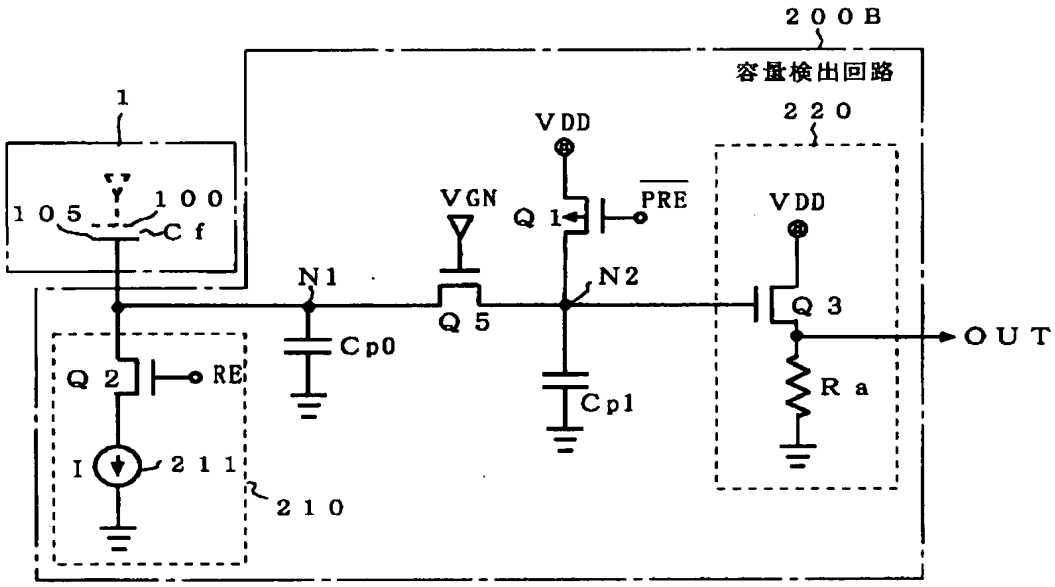
[Drawing 4]



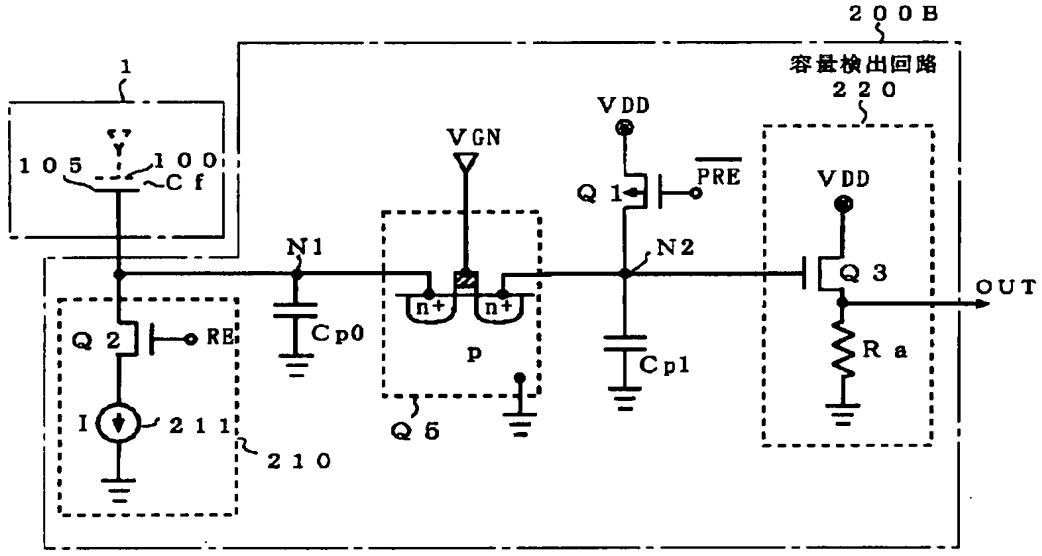
[Drawing 5]



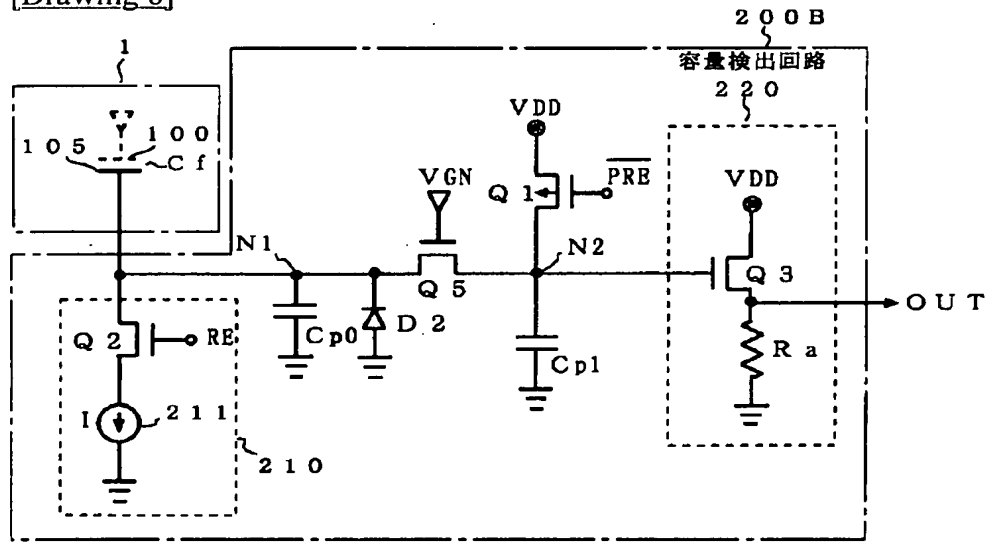
[Drawing 6]



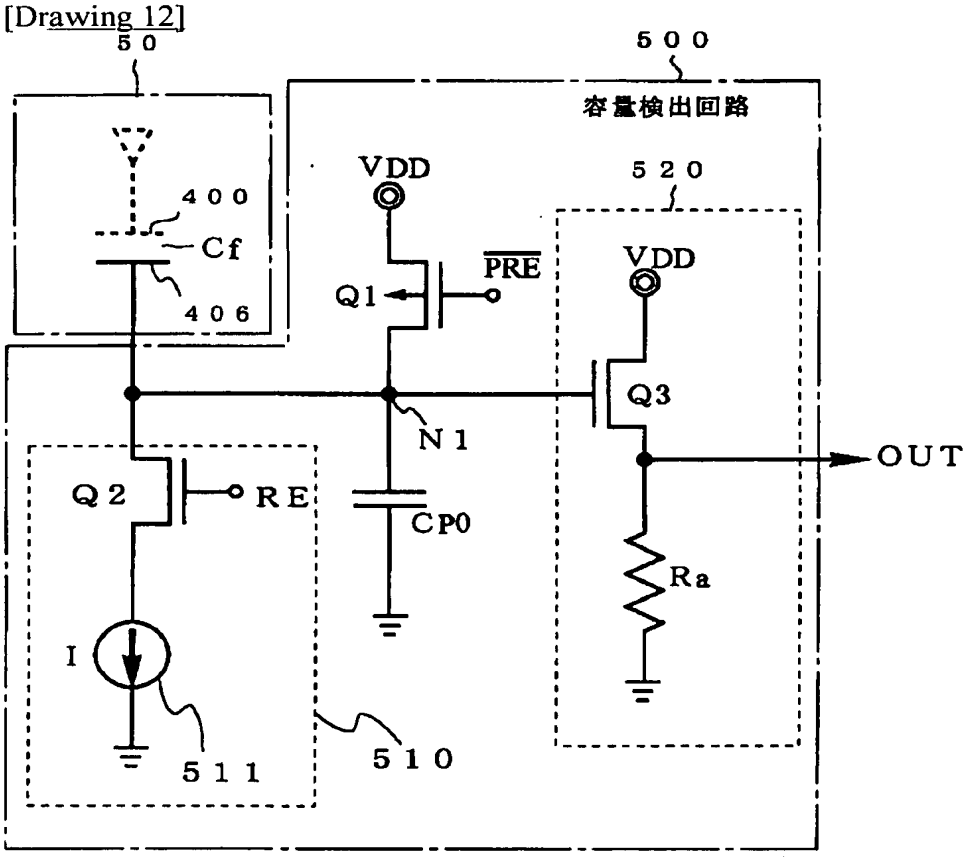
[Drawing 7]



[Drawing 8]



[Drawing 12]



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CLAIMS

[Claim(s)]
[Claim 1] In the record playback discrete-type thin film magnetic head which has the reproducing head and the single magnetic pole mold vertical recording head using a magneto-resistive effect The above-mentioned vertical recording head has the gap film formed between the 1st magnetic pole (auxiliary magnetic pole), the 2nd magnetic pole (main pole), and the 1st and 2nd magnetic poles of the above, and the above-mentioned gap film and the width of face of the 1st magnetic pole of the above which counters The magnetic head for vertical recording characterized by the magnetic film which is large and constitutes the 2nd magnetic pole of the above from width of face of the above-mentioned gap film and the 2nd magnetic pole of the above which counters consisting of multilayers.

[Claim 2] The magnetic head for vertical recording according to claim 1 characterized by the multilayers of the 2nd magnetic pole of the above consisting of a laminating of a magnetic film and a nonmagnetic membrane.
[Claim 3] The magnetic head for vertical recording according to claim 1 or 2 characterized by the saturation magnetic flux density (Bs) of the cascade screen of the magnetic film of the 2nd magnetic pole of the above and a nonmagnetic membrane being more than 1.7 tesla (T).
[Claim 4] Claims 1, 2, and 3 characterized by the thickness of the one layer of the above-mentioned nonmagnetic membranes in the multilayers of the 2nd magnetic pole of the above being 1-30nm are the magnetic head for vertical recording of a publication either.
[Claim 5] Claims 1, 2, 3, and 4 to which the multilayers which constitute the 2nd magnetic pole of the above are characterized by being formed by the spatter or the galvanizing method are the magnetic head for vertical recording of a publication either.
[Claim 6] 5 is [claim 1 thru/or] the magnetic disk drive characterized by coming to carry the magnetic head for vertical recording of a publication either.

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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention relates to the magnetic disk drive which carried the thin film magnetic head and it which are used for record and playback of the signal in a magnetic disk drive etc.
[0002]
[Description of the Prior Art] In a magnetic disk drive, the data on a record medium are written by the magnetic head. In order to make [many] storage capacity per unit area of a magnetic disk, it is necessary to carry out densification of the surface recording density. However, by the present recording method within a field, when the bit length recorded becomes small, there is a problem of it becoming impossible to raise surface recording density because of the heat fluctuation of magnetization of a medium.
[0003] There is a vertical recording method which records a magnetization signal in the direction perpendicular to a medium for solution of this problem. Also in a vertical recording method, a magneto-resistive effect mold head (MR head) and a giant magneto-resistance mold head (GMR head) with a still larger playback output can be used for playback. On the other hand, it is necessary to use a single magnetic pole head for record.
[0004] Moreover, also in vertical recording, it is necessary to improve track density and track recording density for improvement in recording density. among these -- the improvement in track density sake -- the width of recording track of the magnetic head -- a detail -- it is necessary to make it highly precise Furthermore, in vertical recording, there is a problem which a noise generates by an external magnetic field etc. For example, JP,7-225901,A has the publication about the spike noise by the external magnetic field. Moreover, it is thought that the problem of the noise after record has the unstable magnetic domain of the main pole, and it is because a magnetic domain moves.
[0005] About single-domain-izing the magnetic domain of a pattern, the example which attained single domain-ization of a pattern is indicated by forming and multilayers-izing a non-magnetic layer with much Cu by changing the plating conditions of CoFeCu in the 198th electrochemistry societies and the meeting summary No. (The 198th meeting of The Electrochemical Society, Meeting Abstracts, No.582) 582. However, there is no description about a vertical recording head.
[0006]
[Problem(s) to be Solved by the Invention] Although a means to detect a spike noise and to avoid an error is indicated in invention of JP,7-225901,A, there is no description about reduction of the noise in the magnetic head.
[0007] The purpose of this invention is to offer a magnetic disk drive with the high stability which carried the magnetic head for vertical recording without the noise after record, its production approach, and its magnetic head for vertical recording.
[0008]
[Means for Solving the Problem] The magnetic disk drive which carried the magnetic head for vertical recording of this invention, and it In the record playback discrete-type thin film magnetic head which has the reproducing head which used the magneto-resistive effect for playback, and has a single magnetic pole mold vertical recording head in record the above-mentioned vertical recording head Have the 1st magnetic pole (auxiliary magnetic pole) and the 2nd magnetic pole (main pole),

have the gap film formed between the above 1st and the 2nd magnetic pole of the above, and the above-mentioned gap film and the width of face of the 1st magnetic pole of the above which counters It is larger than the width of face of the above-mentioned gap film and the 2nd magnetic pole of the above which counters, and is characterized by the magnetic film which constitutes the 2nd magnetic pole of the above consisting of multilayers.

[0009] The magnetic head for vertical recording of this invention is equipped with the following descriptions still more preferably. It is characterized by the above-mentioned multilayers of the 2nd magnetic pole of the above consisting of a laminating of a magnetic film and a nonmagnetic membrane. Moreover, the saturation magnetic flux density (Bs) of the cascade screen of the magnetic film of the 2nd magnetic pole of the above and a nonmagnetic membrane is more than 1.7 tesla (T), the thickness per layer of the above-mentioned nonmagnetic membrane in the magnetic film of the 2nd magnetic pole of the above is 1-30nm, and the multilayers which constitute the 2nd magnetic pole of the above are formed by the spatter or the galvanizing method.

[0010] As mentioned above, with the single magnetic pole head used by the vertical recording method, there is a problem which a noise generates by an external magnetic field etc. As the solution approach, it found out that what is necessary was just to multilayers-ize the magnetic film of the main pole. That is, by multilayers-izing, the magnetic domain of the main pole can be stabilized and the noise which this generates from turbulence of a magnetic domain can be controlled.

[0011] There are a spatter and the galvanizing method as the magnetic film formation approach. What is necessary is just to carry out the spatter of a magnetic film and the nonmagnetic membrane by turns in a spatter. Magnetic films, such as CoNiFe, FeCo, and FeNi, can be used as a magnetic film. As a nonmagnetic membrane, a simple substance and alloys, such as Cr, Cu, Ta, W, Ru, Mo, Nb, Ru, Rh, and Ag, can be used. The thickness of a nonmagnetic membrane should just be 1-30nm. By the galvanizing method, CoNiFe, FeNi, CoNi, CoFeV, CoFeW, CoFeCu, FeCo, etc. can be used as a magnetic film. As a nonmagnetic membrane, a simple substance or alloy film, such as Cr, Cu, Mo, Pd, and Au, can be used, and thickness should just be 1-30nm.

[0012]

[Embodiment of the Invention] Drawing 1 is the conceptual diagram of the magnetic disk drive of one example of this invention (however, the magnifying power of drawing is not uniform). A magnetic disk drive performs record and playback of the magnetization signal 4 by the magnetic head 3 fixed at the tip of a base material 2 on the magnetic disk 1.

[0013] The important section outline of the record playback discrete-type thin film magnetic head for the conventional record within a field is shown in drawing 2 . This magnetic head has the structure where the laminating of the recording head was carried out on the reproducing head using a magneto-resistive effect. here -- 5 of drawing -- the giant magneto-resistance film and 6 -- an electrode and 7 -- a magnetic core and 8 -- an insulator layer and 9 -- a conductor -- as for a coil and 10, lower shielding and 11 are up shielding.

[0014] The basic structure of the thin film magnetic head for record playback discrete-type vertical recording for vertical recording is shown in drawing 3 . 12 of drawing is the main pole and 14 is an auxiliary magnetic pole. It has the structure where the laminating of the single magnetic pole mold recording head was carried out on the reproducing head which used the magneto-resistive effect also in this magnetic head. The big difference in the magnetic head of above-mentioned drawing 3 and drawing 2 is that between the main pole 12 and the auxiliary magnetic poles 14 is open by the magnetic head for vertical recording (drawing 3) to the gap film [being thin (for example, 0.2 micrometers)] being between the up magnetic core 7 and the up shielding 11 (a lower magnetic core being made to serve a double purpose) of the reproducing head by the medium opposed face in the head for the record within a field (drawing 2) greatly (for example, 5-10 micrometers).

[0015] The outline of the principle of a vertical recording method is shown in drawing 4 . The field which came out of the main pole 12 passes along a recording layer and a backing layer, forms the magnetic circuit included in the auxiliary magnetic pole 14, and records a magnetization pattern on a recording layer. The phenomenon which a field is revealed from generating of the noise by the magnetic domain of the main pole 12 moving at this time and the tip of the main pole 12, and eliminates the magnetization signal of a medium happens.

[0016] For this reason, a magnetic domain is single-domain-ized by considering as the main pole 15

multilayers-ized like drawing 5 in this invention. As a cascade screen, by the spatter, the ten-layer laminating of CoNiFe (30nm of thickness) and the Cr (1nm of thickness) was carried out, and the main pole was obtained. As a magnetic film, the spatter of CoFe, FeNi, the CoNi, etc. may be similarly carried out other than the above. 20nm - 100nm should just be used for thickness. As a nonmagnetic membrane, the spatter of Cu, Cu, Ta, Mo, Pd, the Au, etc. may be carried out, for example. The thickness of one layer of non-magnetic layers is just 1nm - 30nm.

[0017] When multilayers were formed using the galvanizing method, the magnetic film carried out the 15-layer laminating of CoNiFe of 20nm of thickness, and the Cu of 2nm of thickness, and obtained the main pole. Other than the above, FeNi, CoNi, CoFeV, CoFeW, CoFeCu, FeCo, etc. can be used as a magnetic film. 20nm - 100nm should just be used for thickness. Cr, Cu, Ta, Mo, Pd, Au, etc. can be used for a nonmagnetic membrane, and the thickness per layer is just 1nm - 30nm.

[0018] The saturation magnetic flux density (Bs) of the main pole 15 which consists of a cascade screen of the above-mentioned magnetic film and a nonmagnetic membrane (the 2nd magnetic pole) was more than 1.7 tesla (T). Moreover, the magnetic domain of the main pole could be stabilized by the above-mentioned configuration, and generating of a noise was lost. By carrying this magnetic head for vertical recording, the magnetic disk drive of an extremely stable vertical recording method was producible.

[0019]

[Effect of the Invention] By using the main pole which consists of multilayers of a magnetic film and a nonmagnetic membrane, the magnetic head for vertical recording without generating of a noise is produced, and an extremely stable magnetic disk drive is obtained.

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DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] The schematic diagram of the concept of the magnetic disk drive in the gestalt of operation of this invention.
[Drawing 2] The important section schematic diagram of the conventional magnetic head for the record within a field.
[Drawing 3] The important section schematic diagram of the conventional magnetic head for vertical recording.
[Drawing 4] The schematic diagram of the magnetic head for vertical recording, and a magnetic disk.
[Drawing 5] The important section schematic diagram of the magnetic head for vertical recording in the gestalt of operation of this invention.
[Description of Notations]
1 -- magnetic disk, 2 -- base material, and 3 -- the magnetic head, 4 -- magnetization signal, 5 -- giant magneto-resistance film, and 6 -- an electrode, 7 -- magnetic core, 8 -- insulator layer, and 9 -- a conductor -- a coil, 10 -- lower shielding, and 11 -- up shielding, 12 -- main pole, a 14 -- auxiliary magnetic pole, and the main pole formed into 15 -- multilayers.

[Translation done.]

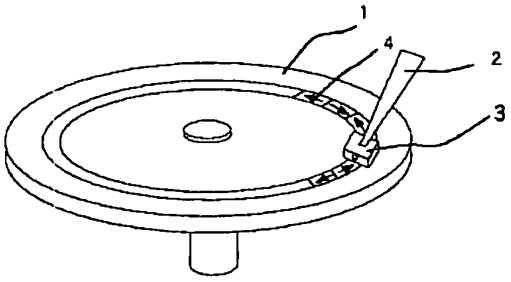
* NOTICES *

1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

DRAWINGS

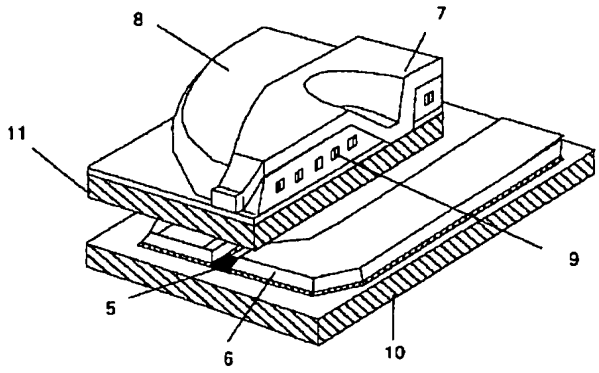
[Drawing 1]

図1



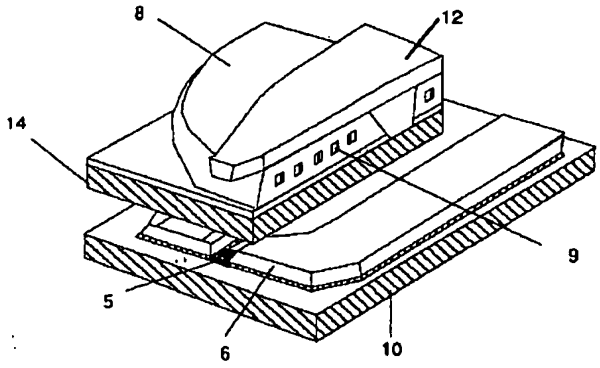
[Drawing 2]

図2



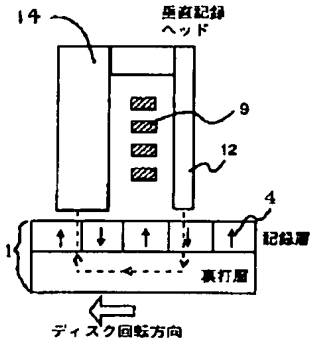
[Drawing 3]

図3



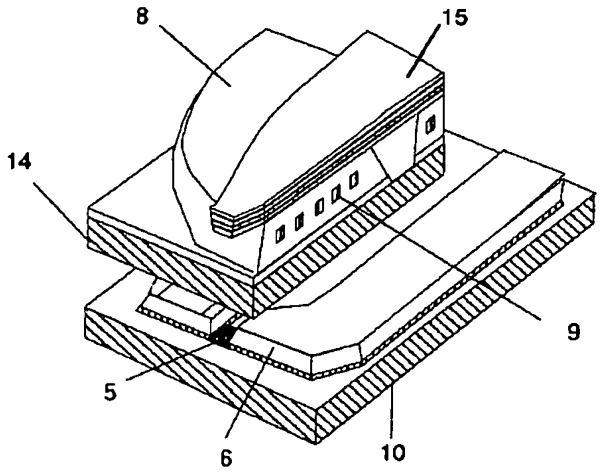
[Drawing 4]

図4



[Drawing 5]

図5



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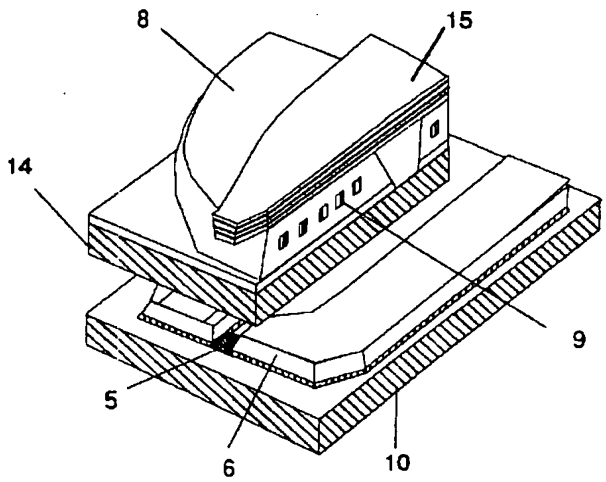
最終頁に続く

(54)【発明の名称】　垂直記録用磁気ヘッドおよびそれを搭載した磁気ディスク装置

(57)【要約】
【課題】ノイズ発生のない垂直記録用磁気ヘッドを作製し、これを用いた安定性の高い磁気ディスク装置を得る。
【解決手段】磁性膜と非磁性膜の多層膜からなる主磁極を用いた垂直記録用磁気ヘッドを作製し、それを用いた磁気ディスク装置を作製することによって、主磁極の磁区の安定を図り、ノイズの発生を抑える。

図５



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【特許請求の範囲】

【請求項１】磁気抵抗効果を用いた再生ヘッドと単磁極型垂直記録ヘッドを有する記録再生分離型薄膜磁気ヘッドにおいて、上記垂直記録ヘッドは第１磁極（補助磁極）と第２磁極（主磁極）と上記第１および第２磁極の間に形成されたギャップ膜を有し、上記ギャップ膜と対向する上記第１磁極の幅は、上記ギャップ膜と対向する上記第２磁極の幅より大きく、上記第２磁極を構成する磁性膜が多層膜からなることを特徴とする垂直記録用磁気ヘッド。

【請求項２】上記第２磁極の多層膜が磁性膜と非磁性膜との積層からなることを特徴とする請求項１記載の垂直記録用磁気ヘッド。

【請求項３】上記第２磁極の磁性膜と非磁性膜との積層膜の飽和磁束密度（Ｂｓ）が１．７テスラ（Ｔ）以上であることを特徴とする請求項１または２記載の垂直記録用磁気ヘッド。

【請求項４】上記第２磁極の多層膜中の上記非磁性膜１層の膜厚が１～３０ｎｍであることを特徴とする請求項１、２および３のいずれか記載の垂直記録用磁気ヘッド。

【請求項５】上記第２磁極を構成する多層膜が、スパッタ法またはめっき法によって形成されることを特徴とする請求項１、２、３および４のいずれか記載の垂直記録用磁気ヘッド。

【請求項６】請求項１ないし５のいずれか記載の垂直記録用磁気ヘッドを搭載してなることを特徴とする磁気ディスク装置。

【発明の詳細な説明】

【０００１】

【発明の属する技術分野】本発明は、磁気ディスク装置等における信号の記録・再生に用いられる薄膜磁気ヘッドおよびそれを搭載した磁気ディスク装置に関する。

【０００２】

【従来の技術】磁気ディスク装置では、記録媒体上のデータは磁気ヘッドによって読み書きされる。磁気ディスクの単位面積当たりの記録容量を多くするためには、面記録密度を高密度化する必要がある。しかしながら、現状の面内記録方式では、記録されるビット長が小さくなると、媒体の磁化の熱揺らぎのために面記録密度をあげられなくなるという問題がある。

【０００３】この問題の解決のために、媒体に垂直な方向に磁化信号を記録する垂直記録方式がある。垂直記録方式においても、再生には磁気抵抗効果型ヘッド（ＭＲヘッド）および、さらに再生出力が大きい巨大磁気抵抗効果型ヘッド（ＧＭＲヘッド）を用いることができる。一方、記録には、単磁極ヘッドを用いる必要がある。

【０００４】また、垂直記録においても、記録密度の向上のためにはトラック密度と線記録密度を向上する必要がある。このうち、トラック密度向上のためには磁気ヘッドのトラック幅を微細、高精度化する必要がある。さらに、垂直記録では外部磁界等によりノイズが発生する問題がある。例えば、特開平７－２２５９０１号公報には外部磁界によるスパイクノイズに関する記載がある。また、記録後のノイズの問題は、主磁極の磁区が不安定で、磁区が動くことによるものと考えられている。

【０００５】パターンの磁区を単磁区化することに関しては、第１９８回電気化学学会・会議要旨第５８２号（The 198th meeting of The Electrochemical Society, Meeting Abstracts, No.582）において、ＣｏＦｅＣｕのめっき条件を変えることにより、Ｃｕの多い非磁性層を形成し、多層膜化することによって、パターンの単磁区化を図った例が開示されている。しかしながら、垂直記録ヘッドに関する記述はない。

【０００６】

【発明が解決しようとする課題】特開平７－２２５９０１号公報の発明では、スパイクノイズを検出し、エラーを回避する手段が開示されているが、磁気ヘッドでのノイズの低減に関しては記述がない。

【０００７】本発明の目的は、記録後のノイズが無い垂直記録用磁気ヘッドとその作製方法およびその垂直記録用磁気ヘッドを搭載した安定性の高い磁気ディスク装置を提供することにある。

【０００８】

【課題を解決するための手段】本発明の垂直記録用磁気ヘッドおよびそれを搭載した磁気ディスク装置は、再生に磁気抵抗効果を用いた再生ヘッドを有し、記録に単磁極型垂直記録ヘッドを有する記録再生分離型薄膜磁気ヘッドにおいて、上記垂直記録ヘッドは、第１磁極（補助磁極）、第２磁極（主磁極）を有し、上記第１および上記第２磁極の間に形成されたギャップ膜を有し、上記ギャップ膜と対向する上記第１磁極の幅は、上記ギャップ膜と対向する上記第２磁極の幅より大きく、上記第２磁極を構成する磁性膜が多層膜からなることを特徴とする。

【０００９】さらに好ましくは、本発明の垂直記録用磁気ヘッドは、以下の特徴を備える。上記第２磁極の上記多層膜が磁性膜と非磁性膜との積層からなることを特徴とする。また、上記第２磁極の磁性膜と非磁性膜との積層膜の飽和磁束密度（Ｂｓ）が１．７テスラ（Ｔ）以上であり、上記第２磁極の磁性膜中の上記非磁性膜の１層当たりの膜厚が１～３０ｎｍであり、上記第２磁極を構成する多層膜がスパッタ法またはめっき法によって形成される。

【００１０】前述のように、垂直記録法で用いる単磁極ヘッドでは、外部磁界等により、ノイズが発生する問題がある。その解決方法として、主磁極の磁性膜を多層膜化すればよいことを見出した。すなわち多層膜化することにより主磁極の磁区を安定化でき、これにより磁区の乱れから発生するノイズを抑制することができる。

【００１１】磁性膜形成方法としては、スパッタ法およびめっき法がある。スパッタ法では、磁性膜と非磁性膜を交互にスパッタすればよい。磁性膜としてはＣｏＮｉＦｅ，ＦｅＣｏ，ＦｅＮｉ等の磁性膜が利用できる。非磁性膜としてはＣｒ，Ｃｕ，Ｔａ，Ｗ，Ｒｕ，Ｍｏ，Ｎｂ，Ｒｕ，Ｒｈ，Ａｇ等の単体および合金が利用できる。非磁性膜の膜厚は、１～３０ｎｍであればよい。めっき法では、磁性膜としてＣｏＮｉＦｅ，ＦｅＮｉ，ＣｏＮｉ，ＣｏＦｅＶ，ＣｏＦｅＷ，ＣｏＦｅＣｕ，ＦｅＣｏ等が利用できる。非磁性膜としてはＣｒ，Ｃｕ，Ｍｏ，Ｐｄ，Ａｕ等の単体または合金膜が利用でき、膜厚は１～３０ｎｍであればよい。

【００１２】

【発明の実施の形態】図１は本発明の一実施例の磁気ディスク装置の概念図である（但し、図の拡大倍率は均一ではない）。磁気ディスク装置は、磁気ディスク１上に、支持体２の先端に固定された磁気ヘッド３によって磁化信号４の記録・再生を行う。

【００１３】図２に従来の面内記録用の記録再生分離型薄膜磁気ヘッドの要部概略を示す。この磁気ヘッドは、磁気抵抗効果を利用した再生ヘッドの上に記録ヘッドが積層された構造となっている。ここで、図の５は巨大磁気抵抗効果膜、６は電極、７は磁気コア、８は絶縁膜、９は導体コイル、１０は下部シールド、１１は上部シールドである。

【００１４】図３に垂直記録用の記録再生分離型垂直記録用薄膜磁気ヘッドの基本構造を示す。図の１２は主磁極、１４は補助磁極である。この磁気ヘッドにおいても磁気抵抗効果を利用した再生ヘッドの上に単磁極型記録ヘッドが積層された構造となっている。上記図３と図２の磁気ヘッドの大きな違いは、面内記録用のヘッド（図２）においては媒体対向面で上部磁気コア７と再生ヘッドの上部シールド１１（下部磁気コアを兼用する）との間に薄い（例えば、０．２μｍ）のギャップ膜があるのに対し、垂直記録用磁気ヘッド（図３）では主磁極１２と補助磁極１４の間が大きく（例えば、５～１０μｍ）開いていることである。

【００１５】図４に垂直記録法の原理の概略を示す。主磁極１２から出た磁界は記録層、裏打ち層を通り、補助磁極１４に入る磁気回路を形成し、記録層に磁化パターンを記録する。このとき主磁極１２の磁区が動くことによるノイズの発生や、主磁極１２の先端から磁界が漏洩して媒体の磁化信号を消去する現象が起こる。

【００１６】このため、本発明においては図５のように多層膜化した主磁極１５とすることにより、磁区を単磁区化する。積層膜としては、スパッタではＣｏＮｉＦｅ（膜厚３０ｎｍ）とＣｒ（膜厚１ｎｍ）を１０層積層させて主磁極を得た。磁性膜としては、上記の他にＣｏＦｅ，ＦｅＮｉ，ＣｏＮｉ等を同様にスパッタしてもよい。膜厚は、２０ｎｍ～１００ｎｍを用いればよい。非磁性膜としては、例えばＣｕ，Ｃｕ，Ｔａ，Ｍｏ，Ｐｄ，Ａｕ等をスパッタしてもよい。非磁性層１層の膜厚は１ｎｍ～３０ｎｍとすればよい。

【００１７】めっき法を用いて多層膜を形成する場合、磁性膜は、例えば膜厚２０ｎｍのＣｏＮｉＦｅと膜厚２ｎｍのＣｕを１５層積層させて主磁極を得た。上記の他に、磁性膜としては、ＦｅＮｉ，ＣｏＮｉ，ＣｏＦｅＶ，ＣｏＦｅＷ，ＣｏＦｅＣｕ，ＦｅＣｏ等が利用できる。膜厚は、２０ｎｍ～１００ｎｍを用いればよい。非磁性膜は、Ｃｒ，Ｃｕ，Ｔａ，Ｍｏ，Ｐｄ，Ａｕ等を使用でき、１層当たりの膜厚は１ｎｍ～３０ｎｍとすればよい。

【００１８】上記磁性膜と非磁性膜との積層膜からなる主磁極（第２磁極の）１５の飽和磁束密度（Ｂｓ）は１．７テスラ（Ｔ）以上であった。また、上記構成により主磁極の磁区を安定化でき、ノイズの発生がなくなった。この垂直記録用磁気ヘッドを搭載することにより、安定性の高い垂直記録方式の磁気ディスク装置を作製できた。

【００１９】

【発明の効果】磁性膜と非磁性膜の多層膜からなる主磁極を用いることにより、ノイズの発生のない垂直記録用磁気ヘッドを作製し、安定性の高い磁気ディスク装置を得る。

【図面の簡単な説明】

【図１】本発明の実施の形態における磁気ディスク装置の概念の概略図。

【図２】従来の面内記録用磁気ヘッドの要部概略図。

【図３】従来の垂直記録用磁気ヘッドの要部概略図。

【図４】垂直記録用磁気ヘッドと磁気ディスクの概略図。

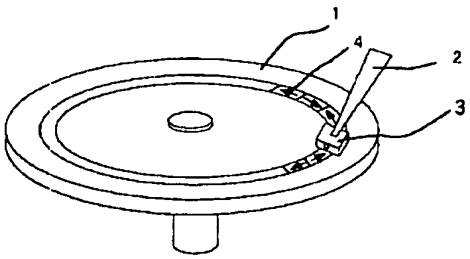
【図５】本発明の実施の形態における垂直記録用磁気ヘッドの要部概略図。

【符号の説明】

１…磁気ディスク、２…支持体、３…磁気ヘッド、４…磁化信号、５…巨大磁気抵抗効果膜、６…電極、７…磁気コア、８…絶縁膜、９…導体コイル、１０…下部シールド、１１…上部シールド、１２…主磁極、１４…補助磁極、１５…多層膜化された主磁極。

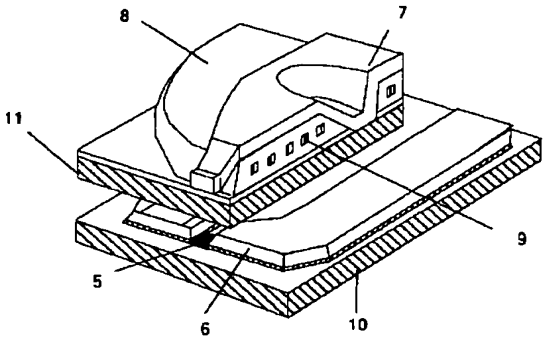
【図１】

図1



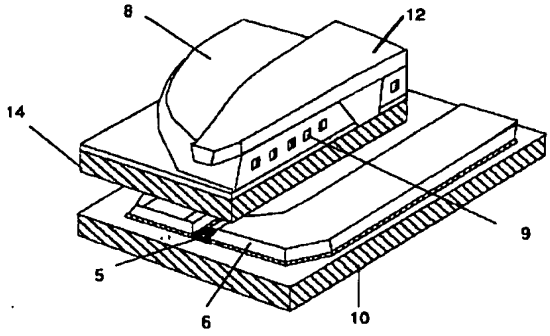
【図２】

図2



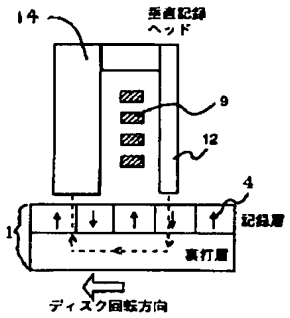
【図３】

図3



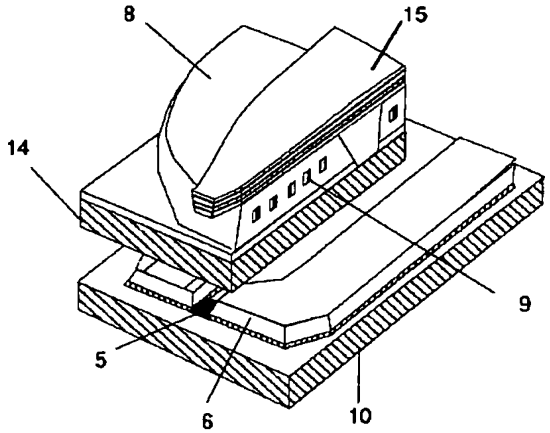
【図４】

図４



【図５】

図５



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